Original Article

Analysis of respiratory function and muscle strength of elite judo athletes and sedentary females

EGEMEN ERMIŞ, ALI KERIM YILMAZ, HAKAN MAYDA , AYDAN ERMIS

Yaşar Doğu Faculty of Sports Sciences, Ondokuz Mayis University, Samsun, Turkey

ABSTRACT

The purpose of this study is to analyse the respiratory function and muscle strengths of elite female judo athletes and sedentary females. 20 elite female judo athletes (EG) and 20 sedentary healthy females (CG) participated in our study. The subjects' respiratory function tests were conducted in sitting position with spirometry, while the respiratory muscle strength tests were conducted by using intraoral barometry. SPSS 22.0 program was used for statistical analysis. When EG and CG were analysed in terms of respiratory functions, no statistically significant difference was found ($p>0.05$). However, when MIP* and MEP** values were analysed, it was found statistically that female judo athletes (EG) had much higher results when compared with sedentary females (CG) (*$p<0.05$, **$p<0.01$). As a conclusion, it can be seen that elite female judo athletes had stronger respiratory muscles when compared with sedentary females, while their lung capacities were found to be similar. Based on the results of our study, it is thought that by doing extra respiratory muscle and function developing trainings, these parameters influencing performance can be developed in female judo athletes. In addition, our study has the characteristic of a reference in terms of respiratory functions and especially respiratory muscle strength in the branch of judo. **Keywords:** Female judo athletes; Respiratory; MIP; MEP.

Cite this article as:
Ermiş, E., Yılmaz, A.K., Mayda, H., & Ermis, A. (2019). Analysis of respiratory function and muscle strength of elite judo athletes and sedentary females. *Journal of Human Sport and Exercise*, *14*(3), 705-710. doi:https://doi.org/10.14198/jhse.2019.143.20

Corresponding author. *Yasar Dogu Faculty of Sport Science, Ondokuz Mayıs University, 55105, Samsun, Turkey.*
E-mail: hakan.mayda@omu.edu.tr
Submitted for publication October 2018
Accepted for publication December 2018
Published September 2019 (*in press* January 2019)
JOURNAL OF HUMAN SPORT & EXERCISE ISSN 1988-5202

doi:10.14198/jhse.2019.143.20

INTRODUCTION

Healthy respiration functions and strong respiratory muscles have a great significance for athletes (Shin et al., 2017). During exercise, athletes inhale and exhale thousands of times and meanwhile their respiratory muscles work intensely (Amonette & Dupler, 2002). Studies conducted clearly show that high values in respiratory functions and respiratory muscle strength have acute and chronic positive effect on athletes' performances (Özdal, 2016; Özdal et al., 2016). Respiratory functions and respiratory muscle strength can be measured objectively and physiological characteristics can be found for patients, healthy individuals or athletes and average values can be found for branches.

Maximal inspiratory mouth pressure (MIP) and maximal expiratory mouth pressure (MEP) are frequently used to measure inspiratory and expiratory muscle strength. These data reflect the combined force forming capacity of inspiratory and expiratory muscles during a semi-static constriction. MIP and MEP are generally used as a reference for muscle training in elite athletes (HajGhanbari et al., 2013). Respiratory functions similarly have great significance in athletes in terms of their effect on performance. It is a known fact that athletes with developed respiratory muscles and respiratory functions stand out in performance parameters of the sport they are doing and even specific exercises are developed to improve these functions (Forbes et al., 2011; Arend et al., 2015; Lomax & McConnell, 2009).

In branches which are categorized according to weight, especially like judo, some cardiovascular problems are known to occur due to over loading and due to excessive weight in heavy weight athletes. In studies they conducted, experts reported that the changes in systems such as muscosceletal and respiratory system influence athletes' performance (Berglund et al., 2011; Shin et al., 2017).

When the literature is reviewed, it can be seen that researches generally intensify on male athletes and that there are limited numbers of studies especially in respiratory muscle strength. In studies which analysed the differences in gender in terms of respiration, no obvious differences were found (O'Brien et al., 2009).

The primary aim of our present study was planned as finding out respiratory functions and MIP and MEP characteristics in elite female judo athletes and to compare with sedentary females.

MATERIAL AND METHOD

Subjects

A total of 40 volunteers, 20 female judo athletes between the ages of 18 and 25 who were elite athletes as the experimental group (EG) and 20 sedentary healthy females as the control group (CG) participated in our study. The athletes were given a questionnaire before the study and those who had a history of injury or those who had a serious injury were excluded from the study.

Measurements

Gaia 359 Plus BodyPass body analyser was used to find out the height, weight and BMI parameters of the subjects who participated in the study. The results were recorded as height (cm), weight (kg) and BMI (kg/m^2) values. SPIROLAB III (Medical International Research, Rome, Italy) spirometry was used to find out respiratory function tests. Forced vital capacity (FVC), forced expiration volume in 1 second (FEV1), FEV1 FVC ratio (FEV1/FVC) and maximal voluntary ventilation (MVV) values of the subjects were measured respectively. Expirite make flow meter was used to find out the Peak Expiration Flow (PEF) values of the subjects.

MIP and MEP measurement: A MicroRPM (CareFusion Micro Medical, Kent, UK) intraoral barometer was used to find out MIP and MEP parameters. For MIP measurement, after suitable filter and holders were fixed, the nose air way was closed with a clip. The test was completed when the subject was standing with residual volume, the holder was taken into the mouth, and maximal inspiration was made at maximal speed for 1-3 seconds. For MEP measurement, the same method was applied as in MIP. However, unlike residual volume, the test was started at total lung capacity. The measurement was repeated between the two best measurements until 10 cmH_2O difference was left and the best result was recorded in cmH_2O (Lomax & McConell, 2009). A pilot study was conducted before all measurements and the tests were completed within the same hour interval for all the subjects (between 14:00 AM and 16:00 AM).

Statistical Analysis

SPSS IBM 22.0 program was used for statistical analysis. The data were presented as mean and standard deviation. Normality assumption of the data was conducted with Shapiro-Wilk test, while the homogeneity assumption was conducted with Levene test. In comparisons between groups, Independent Sample T-test was used for data sets which were normally distributed, while Mann-Whitney U test was used for data sets which were not normally distributed. The results were assessed statistically at $p<0.05$ significance level.

RESULTS

Table 1. Comparison of descriptive data of the groups

Variables	Group	N	Mean ± S.D	t	p
AGE (years)	JUDO	20	20.24±1.56	-1.209	0.239
	CONTROL	20	21.19±2.76		
HEIGHT(cm)	JUDO	20	163.76±5.29	-0.669	0.509
	CONTROL	20	165.06±5.82		
WEIGHT (kg)	JUDO	20	54.88±6.20	-0.760	0.453
	CONTROL	20	56.38±4.96		
BMI (kg/m^2)	JUDO	20	20.51±2.46	-0.271	0.788
	CONTROL	20	20.70±1.63		

Table 1 presents the descriptive data of the groups as mean and standard deviation. When descriptive data were analysed statistically, no statistically significant difference was found in age, height, weight and BMI ($p>0.05$).

Table 2. Comparison of respiratory function parameters of the judo athletes and the control group

Variables	Group	N	Mean ± S.D	t	p
FVC(lt)	JUDO	20	3.51±0.47	-.750	0.459
	CONTROL	20	3.66±0.71		
FEV1(lt)	JUDO	20	3.15±0.41	-1.037	0.308
	CONTROL	20	3.31±0.48		
FEV1/FVC(%)	JUDO	20	90±0.09	-.682	0.501
	CONTROL	20	92±0.08		
MVV(lt/min)	JUDO	20	128.12±16.66	0.985	0.333
	CONTROL	20	120.94±24.26		
PEF(lt/sec)	JUDO	20	451.35±31.20	0.31	0.976
	CONTROL	20	450.69±80.97		

Table 2 presents the respiratory function test results of the groups as mean and standard deviation. When the groups' respiratory function test results were analysed, no statistically significant difference was found ($p>0.05$).

Table 3. Comparison of respiratory muscle strength of the judo athletes and the control group

Variables	Group	N	Mean ± SD	t	p
MIP(cmH_2O)	JUDO	20	103.47±23.24	3.304	**0.003***
	CONTROL	20	81.38±14.40		
MEP(cmH_2O)	JUDO	20	135.70±27.07	4.974	**<0.001****
	CONTROL	20	95.06±19.47		

**p<0.05, **p<0.001*

Table 3 presents the respiratory muscle strength results of the groups in mean and standard deviation. When the respiratory muscle strength values between groups were analysed, it was statistically found that female judo athletes had higher MIP and MEP values when compared with sedentary individuals (*p<0.05,**p<0.01).

DISCUSSION

Respiratory function and muscle strength tests performed in different sport branches are important sources for researches conducted and at the same time they allow for the opportunity to assess the results within a cause-effect relationship. However, when the studies conducted are analysed, it can be seen that while there are sources about especially men in different sport branches (Chin et al., 1992; Zaccagni et al., 2009), there is a lack of sources in respiratory function tests, especially respiratory muscle strength, in martial arts in both males and females.

Our study is on judo, which is one of the popular martial arts. It can be seen clearly from the literature review that due to factors such as place and training systems, etc., martial arts with different systems and types have different physical and physiological characteristics (Chaabene et al., 2012; Murata et al., 2016; Ouergui et al., 2015). When respiratory functions (FVC, FEV1, FEV1/FVC, MVV, PEF) were analysed in our study, no statistically significant difference was found between EG and CG. Studies conducted show that in measurements which were conducted without any training protocol, female athletes and healthy individuals showed parallel results with the results of EG group in our study (Kellens et al., 2011; Romer et al., 2004). However, it can be clearly seen that function values show high results in groups in which some specific programs are organized such as respiratory muscle training and especially swimmers (Vasconcelos et al., 2017; Cordain & Stager, 1988; Doherty & Dimitriou, 1997). It is thought that the reason for this is different physiological characteristics of branches and the positive effects of trainings on respiratory functions.

Respiratory muscles have vital importance on athletes' performance and they influence exercise tolerance significantly (Amonette & Dupler, 2002). When the results of our study are examined, it can be seen that female judo athletes have much higher MIP values when compared with sedentary female. The muscles which have primary influence on respiratory muscle strength are diaphragm and external intercostal muscle, while the secondary muscles are trapezius, scalene, sternocleidomastoid, serratus anterior muscles (Cameron & Monroe, 2007). Studies have been found which show that the muscles related with respiratory are developed especially in judo athletes (Radovanovic et al., 2011). When the literature is reviewed, it can be seen that female athletes have much higher MIP and MEP values when compared with healthy individuals, while there are different results among branches (Ohya et al., 2017; Ohya et al., 2016; Rodriguez, 2000). This difference is thought to result from the fact that branch-specific training techniques and different energy

systems are used and also from specific training methods for respiratory muscles. The results of studies conducted are in parallel with this thought (Ohya et al., 2017; Rodriguez, 2000; Cordain & Stager, 1988; Strongoli et al., 2010).

As a conclusion, this study shows that MIP and MEP characteristics in female elite judo athletes show higher results when compared with sedentary healthy females. It is an expected result for exercise-related inspiratory and expiratory muscular pressure of athletes to have higher MIP and MEP values when compared with healthy individuals. The results concluded support the expected results. Our study can be resources for studies about respiratory functions and muscles, which are in limited number especially in female athletes.

REFERENCES

Amonette, W.E., & Dupler, TL. (2002). The effects of respiratory muscle training on VO2 max, the ventilatory threshold and pulmonary function. Journal of Exercise Physiology 5(2), 29-35.

Arend, M., Mäestu, J., Kivastik, J., Rämson, & R., Jürimäe, J., (2015). Effect of inspiratory muscle warm-up on submaximal rowing performance. J Strength Cond Res , 29(1), 213-218. https://doi.org/10.1519/JSC.0000000000000618

Berglund, L., Sundgot-Borgen, J., & Berglund, B. (2011). Adipositas athletica: a group of neglected conditions associated with medical risks. Scandinavian Journal Of Medicine & Science in Sports 21(5), 617-624. https://doi.org/10.1111/j.1600-0838.2011.01322.x

Cameron, M.H., & Monroe, L. (2007). Physical Rehabilitation-E-Book: Evidence-Based Examination, Evaluation, and Intervention. Elsevier Health Sciences.

Chaabene, H., Hachana, Y., Franchini, E., Mkaouer, B., & Chamari, K. (2012). Physical and physiological profile of elite karate athletes. Sports Medicine. 42(10), 829-843.

Chin, M.K., Lo, Y.S., Li, C.T., & So, C.H. (1992). Physiological profiles of Hong Kong élite soccer players. British Journal Of Sports Medicine, 26(4), 262-266. https://doi.org/10.1136/bjsm.26.4.262

Cordain, L., & Stager, J. (1988). Pulmonary structure and function in swimmers. Sports Medicine, 6(5), 271-278. https://doi.org/10.2165/00007256-198806050-00002

Doherty. M., & Dimitriou, L. (1997). Comparison of lung volume in Greek swimmers, land based athletes, and sedentary controls using allometric scaling. British Journal Of Sports Medicine, 31(4), 337-341. https://doi.org/10.1136/bjsm.31.4.337

Forbes, S., Game, A., Syrotuik, D., Jones, R., & Bell, G.J. (2011) The effect of inspiratory and expiratory respiratory muscle training in rowers. Research in Sports Medicine, 19(4), 217-230. https://doi.org/10.1080/15438627.2011.608033

HajGhanbari, B., Yamabayashi, C., Buna, T.R. (2013). Effects of respiratory muscle training on performance in athletes: a systematic review with meta-analyses. The Journal of Strength & Conditioning Research, 27(6), 1643-1663. https://doi.org/10.1519/JSC.0b013e318269f73f

Kellens, I., Cannizzaro, F., Gouilly, P,. & Crielaard, J.M. (2011). Inspiratory muscles strengthtraining in recreational athletes. Rev Mal Respir, 28, 602–8. https://doi.org/10.1016/j.rmr.2011.01.008

Lomax, M., & McConnell, A.K. (2009). Influence of prior activity (warm-up) and inspiratory muscle training upon between-and within-day reliability of maximal inspiratory pressure measurement. Respiration, 78(2), 197-202. https://doi.org/10.1159/000211229

Murata, H., Oshima, S., Torii, S., Taguchi, M., & Higuchi, M. (2016). Characteristics of body composition and cardiometabolic risk of Japanese male heavyweight Judo athletes. Journal of Physiological Anthropology, 35(1), 10. https://doi.org/10.1186/s40101-016-0092-8

O'Brien, T.D., Reeves, N.D, Baltzopoulos, V., Jones, D.A, & Maganaris, C.N. (2009) Strong relationships exist between muscle volume, joint power and whole-body external mechanical power in adults and children. Experimental Physiology, 94(6), 731-738. https://doi.org/10.1113/expphysiol.2008.045062

Ohya, T., Hagiwara, M., Chino, K., & Suzuki, Y. (2017). Maximal inspiratory mouth pressure in Japanese elite female athletes. Respiratory Physiology & Neurobiology, 238, 55-58. https://doi.org/10.1016/j.resp.2017.01.005

Ohya, T., Yamanaka, R., Hagiwara, M., Oriishi, M., & Suzuki, Y. (2016). The 400-and 800-m track running induces inspiratory muscle fatigue in trained female middle-distance runners. The Journal of Strength & Conditioning Research, 30(5), 1433-1437. https://doi.org/10.1519/JSC.0000000000001220

Ouergui, I., Hammouda, O., Chtourou, H., Gmada, N., & Franchini, E. (2014). Effects of recovery type after a kickboxing match on blood lactate and performance in anaerobic tests. Asian Journal Of Sports Medicine, 5(2), 99.

Özdal, M. (2016). Acute effects of inspiratory muscle warm-up on pulmonary function in healthy subjects. Respiratory Physiology & Neurobiology, 227, 23-26. https://doi.org/10.1016/j.resp.2016.02.006

Özdal, M., Bostanci, Ö., Dağlioğlu, Ö., Ağaoğlu, S.A., & Kabadayi, M. (2016). Effect of respiratory warm-up on anaerobic power. Journal Of Physical Therapy Science, 28(7), 2097-2098. https://doi.org/10.1589/jpts.28.2097

Radovanovic, D., Bratic, M., Nurkic, M., & Stankovic, N. (2011). Recovery of dynamic lung function in elite judoists after short-term high intensity exercise. Arch Budo, 7(1), 21-26.

Rodriguez, F.A. (2000). Maximal oxygen uptake and cardiorespiratory response to maximal 400-m free swimming, running and cycling test in competitive swimmers. Journal Of Sports Medicine And Physical Fitness, 40(2), 87.

Romer, L.M., & McConnell, A.K. (2004). Inter-test reliability for non-invasive measures of respiratory muscle function in healthy humans. European Journal Of Applied Physiology, 91(2-3), 167-176. https://doi.org/10.1007/s00421-003-0984-2

Shin, Y.S., Yang. S.M., Kim, J.H., et al. (2017). Respiratory function of the Korean elite judo athletes and non-athletes. Arch Budo, 13, 297-307.

Strongoli, L.M., Gomez, C.L., & Coast, J.R. (2010). The effect of core exercises on transdiaphragmatic pressure. Journal Of Sports Science & Medicine, 9(2): 270.

Vasconcelos, T., Hall, A., & Viana, R. (2017). The influence of inspiratory muscle training on lung function in female basketball players-a randomized controlled trial. Porto Biomedical Journal, 2(3), 86-89. https://doi.org/10.1016/j.pbj.2016.12.003

Zaccagni. L., Onisto, N., & Gualdi-Russo, E. (2009). Biological characteristics and ageing in former elite volleyball players. Journal of Science and Medicine in Sport, 12(6), 667-672. https://doi.org/10.1016/j.jsams.2008.06.006